Astrophysics Research And Analysis

Magnetically-coupled microcalorimeter arrays for x-ray astrophysics

Completed Technology Project (2015 - 2018)

Project Introduction

The "X-ray Surveyor" has been listed by NASA as one of the four major large mission concepts to be studied in the next Astrophysics Decadal Review in its preliminary list of large concepts. One of the key instruments on such a mission would be a very large format X-ray microcalorimeter array, with an array size of greater than 100 thousand pixels. Magnetically-coupled microcalorimeters (MCC) are one of the technologies with the greatest potential to meet the requirements of this mission, and this proposal is one to carry out research specifically to reach the goals of this vision. The "X-ray Surveyor" is a concept for a future mission that will make X-ray observations that are instrumental to understanding the quickly emerging population of galaxies and supermassive black holes at z ~10. The observations will trace the formation of galaxies and their assembly into large-scale structures starting from the earliest possible epochs. This mission would be observing baryons and large-scale physical processes outside of the very densest regions in the local Universe. This can be achieved with an X-ray observatory with similar angular resolution as Chandra but with significantly improved optic area and detector sensitivity. Chandra-scale angular resolution (1" or better) is essential in building more powerful, higher throughput observatories to avoid source confusion and remain photon-limited rather than background-limited. A prime consideration for the microcalorimeter camera on this type of mission is maintaining ~ 1 arcsec spatial resolution over the largest possible field of view, even if this means a slight trade-off against the spectral resolution. A uniform array of 1" pixels covering at least 5'×5' field of view is desired. To reduce the number of sensors read out, in geometries where extremely fine pitch (~50 microns) is desired, the most promising technologies are those in which a thermal sensor such an MCC can read out a sub-array of 20–25 individual 1" pixels. Projections based on the current state of this technology indicate that less than 5 eV energy resolution can be achieved with this sort of geometry. Theoretically, magnetically-coupled microcalorimeters are well-equipped to achieve the very highest energy resolutions, especially when several absorbers are attached to each sensor, increasing the heat capacity. This program will build upon the work carried out by our group on metallic magnetic calorimeters (MMC) and Magnetic penetration thermometers (MPT) in the antecedent program. In this program we will carry out development in three main areas. First, we will develop sensor geometries that are optimized for reading out sub-arrays of pixels with a single sensor of the type that is likely desired by the "X-ray Surveyor". Second, we will further develop large-format arraying prototypes with the engineering of wiring-pixel approaches that are scalable to the large-format arrays that are needed. Third, we will develop the read-out technology that will be necessary, which utilizes the next generation of X-ray microcalorimeter read-out approach, a microwave multiplexing readout.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

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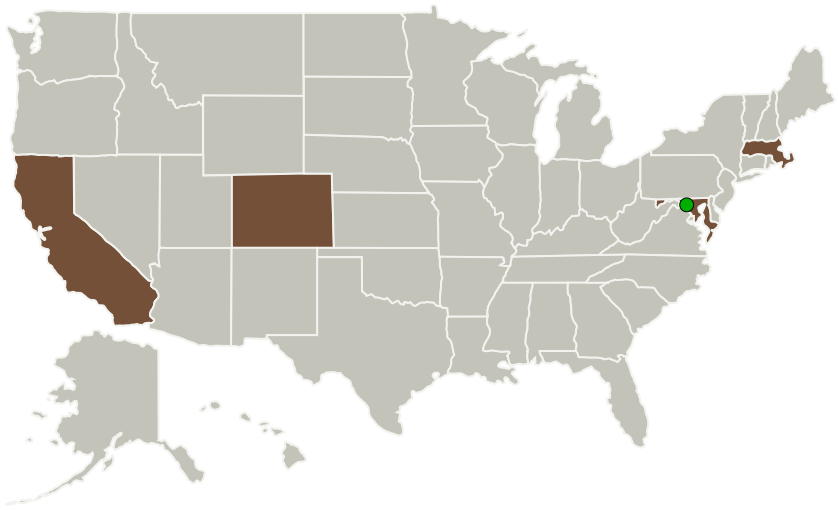
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
California	Colorado
Maryland	Massachusetts

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Simon R Bandler

Co-Investigators:

Alexey Vikhlinin
Frederick S Porter
John E Sadleir
Joel Ullom
Joseph S Adams
Richard L Kelley
Thomas R Stevenson
Christian Enss
Caroline A Kilbourne
Megan E Eckart
Stephen J Smith
David T Leisawitz
John A Mates
Kent D Irwin

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System